

## **RESEARCH PROJECT PLAN**

### **USGS-Biological Resources Division Midcontinent Ecological Science Center**

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#### **Project Title: Natural Resources Decision-Making: Factors in Collaborative Planning for the Southern Greater Yellowstone Area**

#### **Plan of Work:**

##### **Background and Justification:**

“[M]any of society’s greatest challenges lie at the interface of ecology and the social sciences” (*Science*, Vol. 282:279). Management of the Nation’s land and water resources is among the daunting tasks at that disciplinary juncture. In particular, challenges are created at the human-wildland interface, that arena where interactions occur among human activities, resource use, and values and physical and biological components of the environment. Addressing environmental issues arising at this interface requires development and implementation of resource management policies, relying on collaboration between natural resource managers, government officials at all levels, and the public. To be successful in the collaborative process, managers must learn to assess public opinions and values, solicit citizen input, and communicate with the public about natural resource issues and choices. Managers must know the economic effects of proposed changes, community perceptions of existing and proposed conditions, citizen knowledge of changes in resource use, and institutional opportunities and constraints. Although managers and scholars seem to agree that greater inclusion of the public is important for decision-making, generally accepted means to accomplish that task are lacking (Dennis 1998; Tuler and Webler 1999). Although “partnering” with the public (BLM 1998) is considered an appropriate approach, principles for public participation need to be determined in part by the context of the management issue (Tuler and Webler 1999). Working with partners to develop the public participation process and make decisions may be labeled collaborative decision making (Kearney, et al. 1999)

The Social, Economic, and Institutional Analysis Section (SEIAS) has designed an interdisciplinary research strategy involving three interrelated Research Project Plans to answer the question:

#### ***What are the obstacles and opportunities for collaborate planning at the human-wildlands interface?***

These three projects have been developed under a Research Strategic Plan entitled “Economic and Social Factors in Management of Habitats at Risk” (December 1999). We will specifically focus on the collaborative planning process for ungulate management in the southern Greater Yellowstone Area (see

map and setting description below).<sup>1</sup> Our overall aim in the three projects under this strategic plan is to provide managers with specific information needed for the process and also to contribute to the design of successful models for future collaborative planning. This project will examine organizational decision processes.

The Greater Yellowstone area (GYA) has been a high-profile candidate for efforts to restructure natural resources management at the ecosystem level for nearly two decades. Because of the national and international significance of the area, resource management activities in the GYA act as precedents for other regions. It is one of the largest, most nearly intact complexes of wildlife and wilderness in the lower 48 states (Hocker 1979, Greater Yellowstone Coalition 1986) with over 90% of the land in public ownership. Because of the extensive public land, agencies with common, overlapping, or co-terminus jurisdictions but differing mandates can find themselves at odds.

The public lands in the southern GYA have an economic base of tourism, resource extraction, and ranching. Tourist visitation and permanent residents have increased in the past 15 years and thus have driven the expansion of the service economy. As a result, the communities in and around the southern GYA are rapidly changing. In Teton County in 1998, the average income of those moving to the county was five times that of those leaving the county; thirty percent of county residents are seasonal second homeowners (William Collins, Teton County Planner, personal communication). This population growth has resulted in increased interactions between people and their environment, including wildlife populations.

For example, feeding stations set up for elk (*Cervus elaphus*) in the southern GYA have led to concern about ecological effects of this practice. Feeding stations interfere with natural population regulation processes such as food limitation, resulting in large ungulate concentrations (see Coughenour and Singer 1996). Potential impacts include disease outbreak, such as brucellosis and other diseases resulting from increased interaction between elk, bison (*Bison bison*), and cattle (*Bos taurus*). In addition, intensive ungulate browsing can limit regeneration of shrub and tree species that provide habitat for passerine bird species. These ecological issues have economic, social, and institutional ramifications; for example, ranchers face potential economic losses from interspecific disease transmission, and economic benefits derived from hunting and tourism are at risk. Successful development and implementation of management plans addressing these issues necessitate incorporation of ecological, institutional, economic, and sociological understanding specific to this region.

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<sup>1</sup> Many related natural resource issues exist in the region. There have been ongoing discussions about grizzly bear and cattle interactions, the potential for delisting grizzlies from the Endangered Species Act, the reintroduction of wolves into the Greater Yellowstone Ecosystem, the interaction of wolves with livestock and wildlife, and conservation of open space. Although our studies focus specifically on ungulate management, these efforts have potential application to collaborative processes addressing these other issues.

## **Objective:**

The research question common to all three projects is: What are the obstacles and opportunities for collaborative planning at the human-wildlands interface? For a discussion of collaborative planning see Appendix A. All three projects focus on the management of ungulate populations in the southern Yellowstone area, around Grand Teton National Park and the National Elk Refuge.

The objective of the research described in this project plan is to: **assess the institutional feasibility and economic utility of collaborative planning by determining the institutional factors and decision rules that affect natural resource management decisions.**

## **Hypotheses:**

H1: Stakeholders in different collaborative decision processes apply the same orders and weights (ranks) to similar decision variables.

H2: The roles of stakeholder organizations in collaborative decision processes are consistent across time and between different collaborative decision processes.

H3: The preferences of stakeholder organizations for type of decision process are consistent across time and between different decisions.

H4: The perceived roles of stakeholder organizations in collaborative decision processes are consistent with roles as defined by statute or mission statement.

These hypotheses are derived from the literature of public administration and organizational decision making. This literature argues that agencies play consistent roles over time and that a consequence of this is a high level of predictability for a specified agency in a given decision context. One set of variables structuring the roles played by organizations includes the formal declarations of agency purpose, i.e. statutes and mission statements. For a more detailed discussion of these points, see Appendices B and C.

## **Procedures:**

Two studies are planned as part of this project: Economic Decision Analysis and Institutional Analysis. Data collection for both studies will be accomplished through the same procedures. Although data analysis will be completed independently, the results will be reported together. The literature reviews for each study are presented in Appendices B and C.

In phase one we will analyze the players involved in the collaborative management process for ungulate management, and examine their rules of behavior as defined by statute, regulation, and interagency agreements, as well as their incentive structure. We will use (1) the Legal-Institutional Analysis Model (LIAM) to examine the rules of behavior and (2) economic decision analysis to examine the incentive structure and weights of various decision elements. Phase one will provide the initial hypothesis tests and we will repeat hypothesis testing in phase two to compare organizational roles and rules of behavior across two different collaborative decision processes.

## Phase One

First, investigators will review all available documentation on ungulate management plans and planning for the southern GYA. This will include documentation of statutes and regulations defining the roles of organizations involved in ungulate management as well as intra- and inter-agency planning documents, media accounts, records of public hearings or meetings, and other data sources. Data from the document review will be gathered from the agencies and other public sources and analyzed through content analysis. Content analysis is a technique for measuring the frequency of occurrence of selected words or themes in a document or other communication. The focus of the content analysis will be the roles played by involved parties. Second, we will conduct a workshop with agency managers in the southern GYA to gather feedback on these initial investigations and further refine the scope of the project.

Third, we will use the obtained documents and results of the workshop with federal land managers as the initial effort to identify all the stakeholders who might be involved in planning. This will include both organizations with roles well-defined by mission or statute and those with an involvement in the ungulate management decision process as members of interest groups or other citizen organizations. We will use a snowball technique to develop a comprehensive list of potential stakeholders. This technique involves asking initially identified stakeholders to nominate other stakeholder organizations (Lamb and Ponds, 1999). When an organization is named by three different respondents, it will be added to the list. All nominated stakeholders will be contacted to solicit names of additional stakeholders. The snowball process is considered complete when no new names are added and respondents nominate only previously identified organizations.

Fourth, we will interview representatives of all the parties involved in developing ungulate management plans. Representatives from each organization will be selected based on their individual degree of involvement in the ungulate management planning process. For a given organization, it is likely that multiple parties will be interviewed to solicit input from several organizational levels. For example, in Grand Teton National Park it may be desirable to interview managers as well as biologists. Interviews will focus on gathering data for input into the (1) LIAM program (see Appendix C) and (2) economic decision analysis (see Appendix B). The questions posed in the LIAM analysis will define each organization's preferences for type of outcome and type of decision process in ungulate management. These preferences are a reflection of organizational role. Fifth, as part of the economic decision analysis we will use decision theory techniques (see Appendix B) to help stakeholders reformulate those values into measurable objectives.

## Phase Two

In phase two of the project we will work with land managers to identify another collaborative management process (for example, management of wolf populations) and repeat the steps of phase one. Results will be reported in terms of the differences (see data handling below) in institutional roles and incentive structures between the two collaborative processes.

## **Data Handling and Analysis:**

### **Task 1: Establish a baseline of expected organizational behavior**

The first task will be to analyze the behavior of players in planning for ungulate management in the southern GYA. This task will form the baseline for the overall study by identifying the underlying decision factors and processes. Researchers will identify the rules of behavior governing each player. Rules of behavior are defined by statute, regulation, interagency agreement, organizational culture (i.e., institutional analysis) and incentive structure and weighted values (i.e., economic decision analysis).

#### Methods for Institutional Analysis

Following a procedure similar to that reported by Wilds (1990) and Lybecker (1996) in which participants in decision processes were interviewed individually and the results entered into the LIAM program, we will use the LIAM (see Appendix C) to gather and analyze data. The basic method includes seven steps:

- Identify stakeholders. To identify potential respondents we will use a technique similar to that reported by Davis and Davis (1988) and Lamb and Ponds (1999) in which we will contact individuals known to be involved in the process and ask for names of other participants. All stakeholders will be identified so that the universe of potential respondents will be interviewed. Because stakeholders' interests are typically represented by organizations, interview respondents will be organizational representatives. Between 30 and 50 respondents are anticipated.
- Conduct interviews either over the telephone or in person (depending on funding). Interviews will follow the question format of the LIAM.
- Conduct the analysis using the existing LIAM software.
- Report the LIAM role map and power relationships
- Validate the role map and power relationship through "confirmation interviews" with selected stakeholders, or content analysis of the collaborative planning process records. Confirmation interviews will be conducted with twenty percent of respondents.
- Develop a database of organizational roles.
- Restate organizational roles as hypotheses for testing in Phase Two.

#### Methods for Economic Decision Analysis

We will follow the Policy Decision Protocol procedure (Page, et al. 1999) to combine various decision analysis techniques to analyze a multiple stakeholder planning process. Our analysis will facilitate debate and help each stakeholder organization internalize its objectives and values into a comprehensive set of possible solutions.

The basic method includes:

- Identify the players involved with the decision process (decision makers, stakeholders, and experts)
- Identify proper decision analysis technique to fit the situation. The technique will vary based on the type of problem being assessed and the players involved in the final decision.
- Interview decision makers and stakeholders either over the telephone or in person (depending on funding)

- Organize the attributes identified during the interviews into a structured format (develop hierarchy to describe decision)
- Determine the relative importance of the attributes describing the decision problem (assign weights)
- Analyze the set of problem solutions
- Review and validate the problem solutions through “confirmation interviews” with selected players
- Create an implementation plan

## **Task 2: Combine Organizational Roles and Decision Weights and Test Hypotheses**

We do not yet know how to best combine organizational roles and decision weights. Achieving the combination will be a major contribution of this research project. One option is to treat decision weights in the same way as LIAM uses measures of negotiation power. One possible technique is to develop a matrix, with roles on one axis and decision weights on the other. However, the means to combine the two concepts is yet to be determined. The result will couple the LIAM analysis with the economic decision analysis developed in Task I.

We will test the hypothesis that there is consistency in organizational roles and decision weights through a difference of means test (such as the Student T test). Because the number of respondents will be small (estimated to be 30-50 respondents in each collaborative decision process) it may not be possible to conduct more sophisticated analysis. One possibility is to follow the iterative partitioning method of cluster analysis (k-means clustering) procedure reported by Davis and Davis (1988). This method will allow us to partition the data into four groups (consistent with LIAM’s four roles) and to place each respondent in the cluster with the most similar mean.

## **Task 3: Sponsor Workshop for Presentation of the Results.**

We will invite federal and state land managers, as well as other stakeholders, to a workshop to display and discuss the results of this project. The workshop will be conducted in Jackson Hole, Wyoming and will conclude with a stakeholder evaluation of the findings and a discussion of recommendations to land managers arising from the findings.

### **Users:**

The results of this project are intended first to assist land managers in the National Park Service, Bureau of Land Management, U.S. Fish and Wildlife Service, and U.S. Forest Service as they develop and administer collaborative planning processes. Other users include state and local agencies and non-governmental organizations which must participate in the collaborative efforts. Results of the project will be submitted for publication in peer reviewed journals that focus on wildlife management, public administration, and public policy. They may also be submitted to trade journals or non-refereed journals as a means of disseminating information to a broader, non-technical audience.

### **Technology Transfer:**

SEIAS researchers have made several attempts with past studies to effectively transfer results to clients. These efforts have included focus groups of clients, periodic newsletter-type reports to clients, videotape summaries of results, workshops, and scientific publications. The focus group results demonstrated that although clients believe scientific publications are important, those publications are not frequently consulted. The focus group participants indicated a preference for short, easy-to-access printed reports,

videos, and workshops. Our experience with videos was not satisfactory because stand-alone video presentations are expensive to develop and did not meet with high user satisfaction.

In this project we will make periodic reports to clients concerning the progress of our studies and preliminary findings. We will also conduct a workshop for clients and stakeholders at the conclusion of the project (see Task 3, above). Scientific publications are expected from this project.

**Location:**

This work will be accomplished principally in the offices of the Midcontinent Ecological Science Center, with occasional field trips to conduct interviews in the southern GYA.

**Work Schedule:**

Strategic Planning concludes 12/98  
Project Planning concludes 10/99  
Literature Review concludes 11/99  
Phase One concludes 10/2000  
Phase Two concludes 10/2001  
Workshop 3/2002  
Publications completed 10/2003

**Product Schedule:**

Work is expected to be completed by 09/30/2003

**Investigators:**

Principal Investigators

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**Budget:**

Project Plan Title:

Natural Resources Decision-Making: Factors in  
Collaborative Planning for the Southern  
Greater Yellowstone Area

Start Complete

Date: 10/01/98 09/30/03

	FY 99	FY 00	FY 01	FY 02	FY 03
<u>Personnel (FTE's)</u>					
Lamb	0.5	0.75	0.75	0.75	0.75
Burkardt	0.5	0.6	0.6	0.6	0.6
Caughlan	0.4	0.3	0.6 (convert to full time)	0.6	0.6
Sexton	0.3	0.3	0.3	0.3	0.3

**Personnel (Costs in thousands)**

Lamb	\$46	48.5	51	53.5	56
Burkardt	\$26	34.5	39	40	41
Caughlan	\$15.5	12	25	26	27
Sexton	\$14	14.5	15.5	16.5	17
Subtotal	\$101.5	109.5	130.5	136.0	141

**Operations (Costs in thousands)**

Base	\$29	15	17	18	17
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**Totals (In Thousands)**

\$130.5	124.5	147	154	158
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**Total Project Costs (In Thousands): \$714**

**Approval and Concurrence:**

**Project Title:**

Submitted By: \_\_\_\_\_

Nina Burkardt, Social Science Analyst  
SEIAS  
Midcontinent Ecological Science Center

Date

**Approval and Concurrence:**

Check One

Yes    No

☐☒

Needs Review by Institutional Animal Care and Use Committee

Yes    No

☒☐

Needs Review by Statistician

Project Plan Statistically Sound

Concurrence: See attached letter from Dr. Dennis Soden

Peer Reviewers: See attached letters from:

Dr. N. Joseph Cayer, School of Public Affairs, Arizona State University

Dr. Charles Davis, Department of Political Science, Arizona State University

Dr. Louis Weschler, School of Public Affairs, Arizona State University

Dr. Earl Eckstrand, Bureau of Reclamation, Denver, CO

James Griffin, National Elk Refuge, Jackson WY

Section Leader: \_\_\_\_\_

Dr. Berton Lee Lamb, Leader  
SEIAS, MESC

Date

Center Director: \_\_\_\_\_

Dr. Rey Stendell, Director  
Midcontinent Ecological Science Center

Date

## Appendix A

### An Overview of Collaborative Planning

The National Environmental Policy Act (1970) and Forest and Rangeland Renewable Resources Planning Act (1974) mandate public participation in decisionmaking. The National Forest Management Act (NFMA) was passed in 1976. This act, along with the Federal Land Policy Management Act (1978) broadened the types of information to be included in land management decisions for public lands. These changes included more interdisciplinary planning and a requirement for public participation in forest planning (Selin et al. 1997; Steelman 1999). The Bureau of Land Management (BLM 1998) and National Park Service have also moved toward more inclusive management. Other researchers have instituted studies in the GYA with a related emphasis (e.g., Richards and McClusky 1999; McCool, et. al 1999).

Gray (1989) defined collaboration as a process of joint decision making among key stakeholders of a problem domain about the future of that domain. Collaborative decision making means soliciting and analyzing public preferences and values (Dennis 1998) and incorporating those values into management plans. Thus, collaborative decision making has three parts: soliciting (i.e., seeking out information from the public), analyzing (i.e., determining what that information means and communicating that meaning back to the public), and incorporating (i.e., writing the results into plans and implementing the plans consistent with the public expectations).

Salwasser (1994) observed that "...the success or failure of ecosystem management in protecting environments, revitalizing economies, or restoring healthy communities starts and ends with people and their choices--not with nature preserves, databases, ecological classifications, or any other technological tools that are merely useful means to desired ends." Collaboration with citizens is necessary for successful management. This basic fact seems to be well recognized by the large number of land managers who report using collaborative management techniques (Selin et al. 1997). But there are many impediments to successful collaboration. First, citizens hold widely divergent values and expectations (Dennis 1998). Second, citizens' knowledge of law, management practices, and ecological processes may be significantly at odds (Pierce and Lovrich 1986; Lamb and Ponds 1999). Finally, citizens perceive both the facts and management of natural resources differently (Kearney, et. al 1999). Finding a way for citizens and managers to collaboratively work through these impediments is a major challenge for the public servants who manage our nation's public lands.

Recent research (Tuler and Webler 1999) has found that citizens are concerned about 7 principles for public participation (see also Shindler and Neburka 1997): (1) **Access to the process**--access should be fair; (2) **power to influence process and outcomes**--people should feel efficacious; (3) **Structural characteristics promote constructive interaction**--people are concerned with the social interactions involved in planning; (4) **access to information**--people want to hear from the lay public as well as the expert community; (5) **adequate analysis**--people are concerned with valid facts and accountable data collection/analysis; (6) **creating the context for future collaboration**--today's process should build toward future inclusive policy-making; and (7) **consensus on process norms**. Gray (1989) presented those principles in 5 statements: (1) stakeholders are interdependent; (2) solutions emerge from constructive interaction; (3) decisions are joint products; (4) stakeholders are collectively responsible for implementation; and (5) it is an emergent process.

Collaborative management techniques may involve a variety of methods, including hearings, meetings, workshops, and surveys. Not all of these methods are equally viable. For example, Johnson, et. al (1993) showed that input received from meetings and workshops in Oregon was often more polarized than the attitudes expressed from comprehensive public surveys. Research by Peterson et al. (1994) demonstrated that informal processes are often lacking. We plan to assess the institutional feasibility and economic utility of collaborative planning by using economic decision analysis and institutional analysis to determine the factors and rules that drive natural resource decisions.

## **Appendix B**

### Study 1: Economic Decision Analysis

Janis (1989) asserted that "When all vital decisions are made on the basis of a simplistic strategy, the gross misperceptions and miscalculations that remain uncorrected are likely to lead to disaster sooner or later— usually sooner rather than later." Decision-making is a process of choosing among alternative courses of action in order to attain goals and objectives (Forman 1998). Resource management has become increasingly complicated as the number of participants in the decision making process continues to increase. Land managers are now required to cooperate with a variety of public and private interest groups when making resource management decisions. These groups have many conflicting ideas and values about resource management. These differences in values, combined with complex landscape scale physical and ecological systems, complicate the decision making process.

Making tradeoffs between the objectives relating to a decision is a difficult and poorly understood aspect of decision making (Forman 1998). Peterson et al. (1994) reported that legal and political factors are often just as important as biological and sociological factors in the development of long term management programs. The intent of this research is to facilitate effective decision making for ungulate management policy in the southern GYA. This will be achieved through the use of different decision analysis techniques. SEAIS researchers will use the decision analysis methodology to integrate, aggregate, and synthesize information about the values and science of ungulate management into policy relevant solutions.

Several techniques exist to aid in the decision analysis process. These techniques differ based on the number of decision-makers involved, the degree of mathematical sophistication, quality of measurement needed and computational difficulty for the type of problem being assessed (Anselin et al. 1989).

According to Forman (1998), the most frequent decision method used today is *BOGSAT* (a **B**unch of **O**ld **G**uys/**G**als **S**itting **A**round **T**alking). "Although this is a good technique for encouraging open communication and teamwork, these sessions are often dominated by a leader and rarely facilitated" (Forman 1998). Peterson et al. (1994) observed this process with a group of decision-makers attempting to develop an inventory and monitoring program for Olympic National Park. Using the *BOGSAT* technique, several objectives were overlooked and not given appropriate weight with respect to their importance on the overall decision. The *BOGSAT* technique should therefore not be the exclusive decision-making process (Page et al. 1999).

Methods that move beyond the *BOGSAT* approach typically employ either single or multiple attribute decision programs depending on the complexity of the decision. Up until the early 1970's single attribute decision-making models were the only commonly existing programs. Linear programming (LP) is the most commonly used single attribute optimization model. LP is most often used as a tool for economic management decision modeling (Hiller and Liberman 1980). When decision issues become more complex and involve large numbers of stakeholders, single attribute decision models are not appropriate (Wheeler and Russell 1977).



The first computer-based multi-objective decision program model was developed by Hotelling and Fisher in the early 1970's (Nijamp et al. 1990). Since then several multi-objective models have been developed including Multi-Attribute Utility Theory, Surrogate-Worth Trade-off Method, Electre I and II, PROMOTHEE, the Analytic Hierarchy Process, and Conjoint Analysis (Goicoechea et al. 1982; Page 1997).

Goal programming (GP), reported less frequently in the literature, is most common in the field of agricultural economics. GP, developed in the late 1970's, is a form of linear programming designed to incorporate multiple objectives and identify the tradeoffs among them. The downfall of both LP and GP is the lack of an intuitive methodology for deriving weights for the objectives that affect the achievement of the goal (Page et al 1999). This results in the assignment of unrealistic weights to the factors in the decision problem.

The Analytic Hierarchy Process (AHP) was developed by Satty (1980) at the Wharton School of Business (Forman 1999; See Figure 1). AHP allows decision makers to model a complex problem in a hierarchical structure showing the relationships of the goal, objectives (criteria), sub-objectives, and alternatives. AHP allows for the application of data, experience, insight, and intuition in a logical and thorough way.

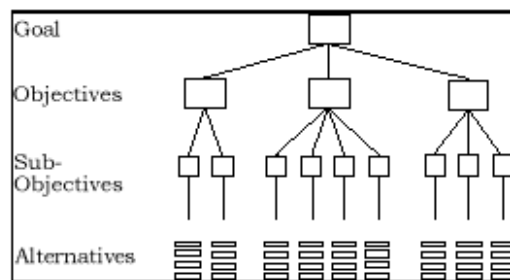


Figure 1. A schematic depiction of the AHP process. Source: Forman (1999).

Results from Anselin et al. (1989) showed that the AHP provides a great advantage for ecological evaluation analysis by allowing simple ranking comparison of a number of sites using different priorities. Forman (1998) states that "Any complex situation that requires structuring, measurement, and/or synthesis is a good candidate for AHP. However, AHP is rarely used in isolation. Rather, it is used along with, or in support of other methodologies."

Conflict resolution and consensus building (i.e., bargaining) are common techniques for resolving complex political problems because they incorporate the multiple influences involved. These techniques ensure all parties have an active role and feel their interests are represented in the multiple factors involved in a decision. Bargaining processes are an integral part of decision-making. However, it is not enough to only undertake consensus building and conflict resolution activities if the decisions cannot be justified and documented. Because problems are often controversial, it is important to be able to describe how collaborative decision processes arrived at the final outcome (Page et al. 1999).

Although formal decision processes are needed, the use of one decision tool is usually not enough to ensure effective decision making. This is likely to be true for ungulate management policy in the southern GYA. Cortner and Schweitzer (1984) conclude that:

It would be an error, however, to equate any analytical model to the 'decision process'; even the 'best' results do not necessarily (and may never) define the chosen plan. Instead, model results are combined with 'outside the model' information, and a decision is reached in the usual way, as a result of political negotiations and mutual accommodations among interested groups and individuals ....

## Appendix C

### Study 2: Institutional Analysis

Institutional analysis is intended to examine the “outside the model” processes that are essential for successful decisionmaking. Institutions are the legal, political and administrative structures and processes through which public policy decisions are made (Ingram et al 1984). Thus, institutional analysis is the study of institutions to discern rules and predict behavior. Interest in institutions as keys to decision processes has increased in recent years as institutions have become larger, more complex, more autonomous, and therefore more influential in political decision making (March and Olsen 1984).

Ostrom (1986) and others have emphasized the importance of multiple levels in institutional analysis. For example, in a given situation the analyst might identify operational choice, collective choice, and constitutional choice as levels of analysis (Ostrom 1986). One or a combination of levels may be appropriate areas of investigation, but it is essential to maintain clarity about the level at which the situation or decision is assessed. Ostrom (1986a) argued for the articulation of a common set of variables for analyzing all types of institutional arrangements to allow for a coherent theory of institutional behavior. Eight clusters of variables were proposed: (1) participants; (2) positions; (3) outcomes; (4) action-outcome linkages; (5) information; (6) control exercised by participants; (7) costs and benefits assigned to outcomes and actions, and (8) the number of iterations of the situation itself.

Ingram and her colleagues (1984) focused on establishing guidelines and standards for institutional analysis in water resource planning. They emphasized the dynamic nature of institutional settings and the importance of actors and their roles and incentives in decision processes. While acknowledging the normative components of institutional analysis, they argued that the factors influencing normative elements can be described and evaluated.

Gough and Ward (1996) argued that environmental decision making is characterized by uncertainty and risk and that decision support systems can mitigate for these factors by providing better information, greater objectivity, and higher efficiency. Decision support systems can be thought of as understood institutional processes.

In endeavoring to understand institutional processes, Chisholm (1995) recognized the primacy of the problem solving function of institutions and proposed a theory of institutions based on that function. In Chisholm’s (1995) view, institutions exist only in response to perceived problems and without problems the institutions would have no reason to persist. This is a little like the March and Olsen (1984) metaphor of policy problems being like garbage cans—the idea that problems float around looking for solutions and they tend to do that by attaching themselves to an organization. Davis and Davis (1988) used an institutional analysis to investigate change in public lands policy. They noted that making public lands policy is marked by the existence of a greater array of policymakers—both government and non-government—engaged in advocacy coalitions. While this complex process can allow multiple points of access for citizens, it is a bewildering mixture of organizations and problems looking for a connection. One factor that Davis and Davis (1988) found that might bring some order to this swirling, unpredictable mass is that advocacy coalitions “possess internally consistent belief systems which provide a rationale for action” (Davis and Davis 1988:4). Davis and Davis (1988: 18-19) found

that in the midst of this process land management agencies often play the role of Broker, connecting problems, organizations, and solutions. It could be expected that organizational roles are also important aspects of the behavior of other players in the garbage can process.

In 1983, the U.S. Fish and Wildlife Service developed a procedure for assessing organizational roles. The procedure, known as the Legal Institutional Analysis Model (LIAM), was developed Lamb (1980) and Wilds (1990). The LIAM is a computer-based model that assesses the political aspects of natural resource conflict (Lamb 1987). The LIAM provides decision-makers with a means to assess the roles, needs, and power of organizations involved in a natural resource dispute (Taylor and Lamb 1989; Lamb and Taylor 1990). Initially, the LIAM was developed for water resource management conflicts. However, the LIAM can be used for other natural resource problems (Lamb and Hindman 1984). The model offers the opportunity to develop an understanding of the organizations involved in natural resource management conflicts. One of the benefits of the LIAM for the resource manager or stakeholder is that it packages knowledge from social science into a method for systematically diagnosing conflicts. The LIAM measures two variables: 1) sources of agency power (e.g., legal authorities, physical control of the resource, constituency, and expertise); and 2) primary decision roles. The model identifies which roles respondents perceive to be present and weighs each role in light of various power factors.

Organizations are remarkably consistent in bargaining situations. The behavior of each organization in a conflict is likely to be consistent with the organization's traditional behavior (Wildavsky 1975). Traditional behavior is determined by mission, experience, and support groups (Lamb 1976, Lamb 1980).

The LIAM expects that organizations will behave according to a combination of four roles: Advocate, Guardian, Broker, and Arbitrator (Table 1). To measure organizational behavior, the LIAM asks a series of questions about each role (Table 2). First, Advocates demand change in the traditional decision processes. Advocates are agencies that call for a change in the status quo approach to natural resources management (Wildavsky 1975). They react to management proposals from others. They may rely on "crusading" and data analysis to advance their position. The factor that distinguishes the Advocate is that they challenge any agency that seeks to impose a developmental or economic-progress philosophy on a problem (Lamb and Lovrich 1987).

Table 1. Attributes of each role in the LIAM. The Attributes cells list the variables that are measured for each role type. The LIAM asks at least two questions to measure each variable.

Role Type	Attributes	Role Type	Attributes
Arbitrator	1) Prefers Formal Processes 2) Desires Objective and Technical Information 3) Desires Documentation of Need	Broker	1) Desires Negotiation 2) Favors Political Considerations 3) Distributes Benefits
Advocate	1) Prefers Change from Traditional Processes 2) Prefers Preservation Values 3) Reacts to Proposals 4 ) Values Nature	Guardian	1) Prefers: Economic Approaches Traditional Processes 2) Values Markets 3) Physical Control of Resource

Second, guardians seek to protect the status quo especially by relying on time-tried decision processes. Guardians attempt to protect themselves and their constituencies from interference, and are interested in preventing challenges to their routines or plans. Guardians work against change in management practices, or project design (Wildavsky 1975). The normal routine for these agencies is interest group consultation or public participation with established clients. Moreover, Guardians profit from well established routines and bargaining processes because they have influential supporters who understand existing decision rules (Beckett and Lamb 1976; Lamb 1976; Lamb 1980).

Table 2. Each role in the LIAM is defined by several attributes. The LIAM contains three questions to measure each attributes. Questions displayed to the respondent are chosen at random from a library of possible questions for each attribute. This table shows one of the questions used to measure a single attribute for each role.

Role Type	Attribute Measured	Question	Measure
Broker	Desire to Negotiate	This organization will promote a negotiated solution in this conflict	5 point Likert scale range from Strongly Agree to Strongly Disagree
Arbitrator	Preference for Formal Processes	In actions like this one, does this organization prefer formal, structured decision processes?	5 point Likert scale range from Almost Always to Almost Never
Advocate	Promotes Change in Traditional Decision Processes	Does this organization urge change from "traditional" land, wildlife, or water resource management practices in actions such as this?	5 point Likert scale range from Almost Always to Almost Never
Guardian	Promotes Economic or Market Processes	In actions such as this one, this organization urges primary consideration of market values.	5 point Likert scale range from Almost Always to Almost Never

Third, brokers seek to manage decisions through tradeoffs and bargaining. Brokers have the ability to facilitate bargaining. They are in a position to help or hinder the planning and implementation process. In bargaining they tend to rely on cost-benefit analysis, mechanisms for controlling resource allocation, and to some extent political considerations. The latter is important because of the nature of the agencies' support groups. The Broker strategy is to guide the decision making in order to maintain the balance-of-power (Beckett and Lamb 1976; Lamb 1976; Lamb 1980).

Finally, arbitrators endeavor to make objective, court-like decisions. Arbitrators typically have statutory

authority to: (1) establish management plans or regulations, (2) establish the guidelines for preparing plans, or (3) direct the implementation of plans undertaken by others. They rely on data collected by others and make authoritative allocations after hearing evidence from all sides.

The results of the role analysis are presented on a role map. Analysts use the role map to understand the interaction of the various roles. In a pattern of behavior something like the advocacy coalitions identified by Davis and Davis (1988) advocates on one side and guardians on the other adjust their behavior to accommodate the presence of an arbitrator or broker. Advocate agencies often develop alliances with arbitrators because the arbitrators rely on advocates for information. For example, advocates often provide the opening to initiate planning or the support around which to build a consensus. Guardians often pursue holding actions or seek to use their constituency to show injury from an advocate's proposals.

Parties do not always assume the most extreme roles. There may be several reasons for this. First, an organization may have a history of moderate behavior or a low level of interest in the conflict. Second, an organization may have a particularly charismatic leader who has a moderate view of the organization's mission. Such a leader might be able to overcome an organization's otherwise extreme tendency (Kasza 1987). Finally, a party may be so politically weak that it is unlikely to play a major part in the conflict and, therefore, assumes a moderate position.